J. Raptor Res. 28(2):100–107

BEHAVIOR AND ACTIVITY OF REHABILITATED BUZZARDS (*Buteo buteo*) RELEASED IN NORTHERN ITALY

DAVIDE CSERMELY AND CARLO VITTORIO CORONA[1]
Dipartimento di Biologia e Fisiologia Generali, Università di Parma, Viale delle Scienze, I-43100 Parma, Italy

ABSTRACT.—The behavior and habitat hunting of 16 rehabilitated common buzzards (*Buteo buteo*) released in northern Italy were analyzed. The buzzards were released individually in different seasons, and their activity was recorded continuously for at least the first 3 d after release and intermittently thereafter until they dispersed from the release site. The birds remained in the surrounding area for more than 100 d, showing a progressive acclimation to the new environment. The released buzzards interacted frequently with wild territorial conspecifics and were attacked by several species of corvids, especially the hooded crow (*Corvus corone*). Nevertheless, such interactions were not the direct cause of dispersal. Some birds defended a territory adjacent to or inside that of a wild buzzard. Prey capture was almost normal, although certainly underestimated. Small mammals and reptiles were most often caught. Although the area chosen for this study had high human population, this was not a major source of interference with the releases. Thus, the buzzards appeared to be able to cope with their new environment being minimally influenced by having been in captivity.

KEY WORDS: *hawks;* Buteo buteo; *behavior; captivity; dispersal; rehabilitation; behavioral ecology.*

Comportamiento y actividad de los *Buteo buteo* rehabilitados y deyados en libertad en el norde de Italia

RESUMEN.—Se analizó la conducta y el habitat de caza de 16 individuos rehabilitados de la especie *Buteo buteo* liberados en el norte de Italia. Los individuos de *B. buteo* fueron liberados en el área de estudio individualmente y en diferentes estaciones; su actividad fue registrada continuamente por al menos tres días después de su liberación e intermitentemente hasta el momento de abandonar el sitio de liberación. Las aves permanecieron en los alrededores del área por más de 100 días, mostrando una progresiva aclimatación al nuevo ambiente. Los individuos liberdos interactuaban frecuentemente con conespecificos territoriales silvestres y fueron atacados por varias especies de cóvidos, especialmente *Corvus corone.* Sin embargo, tales interacciones no fueron la causa directa de su dispersión. Algunas aves defendieron territorios vecinos o al interior de los defendidos por individuos silvestres. La captura de presa fue casi normal, aunque ciertamente subestimada. Tanto pequeños mamíferos como reptiles fueron a menudo capturados. Aunque las áreas escogidas para este estudio tenían una alta población humana, este factor no constituyó una gran fuente de interferencias sobre las liberaciones. En síntesis, *B. buteo* parece ser capaz de incertarse en su nuevo mediambiente siendo escasamente influenciado por su cautividad.
[Traducción de Ivan Lazo]

Several programs for the rehabilitation of raptors have been developed in recent years by institutions devoted to the protection of birds. Standard procedures for raptor rehabilitation have been developed for several species (Nelson 1977, Llewellyn and Brain 1983, Pendleton et al. 1987, Weaver and Cade 1991) as well as the techniques for successful release (Sherrod et al. 1982, Llewellyn 1991). Nevertheless, the adaptation of birds back into the natural habitat is still neglected. In fact, it is almost impossible to get information of the fate of released birds from the literature, because most data refer to survival rate and recovery distance from the release site (Servheen and English 1979, Duke et al. 1981, Ingram 1983, Hamilton et al. 1988). Moreover, little precise information has been compiled on the behavior of individuals after release.

The objective of this study was to fill that gap, investigating in detail the behavior, activity, and intra- and interspecific interactions in a group of common buzzards (*Buteo buteo*) immediately after release following rehabilitation until they dispersed

[1] Present address: Via P. Petronia 89, I-00136 Roma, Italy.

from the area. Such an investigation is likely to be of interest to raptor rehabilitators (Meyers and Miller 1992).

METHODS

The buzzards used in this study were all wild birds, housed temporarily for rehabilitation at the Raptor Rehabilitation Centre (RRC) managed by the Italian Society for the Protection of Birds (LIPU) near Parma. They all originated in northern or central Italy within 100–200 km of the release area. When released the birds were all in perfect physical condition and flying fitness, and were chosen randomly among those ready for releasing. Those possibly imprinted to humans were not considered.

A total of 16 buzzards were studied. Six were adult (two males and four females) and 10 were sub-adults (five males and five females). They were released near the end of each season, from April 1990 to November 1991. Five were studied between winter and spring, four between spring and summer, three between summer and autumn, and four between autumn and winter. Thus, we avoided the most stressful climatic conditions that occur in January–February and in July–August (Kostrzewa and Kostrzewa 1991). The duration in captivity was variable, ranging from a few days to several months, depending on the seriousness of the injury or illness. The mean duration for nine buzzards was 295.5 ± 109.2 d. We did not know the period for the other five, but it was certainly within the same range.

The release site was located within a waterfowl sanctuary managed by LIPU about 15 km north of Parma and 5 km from the Po River. The area is flat and without extensive woodlands but with a high human population density. The site was chosen because of the necessity to observe closely and track the buzzard behavior precisely, even for long distances if necessary. Wild buzzards are regularly present particularly during winter. Several taxa of invertebrates and terrestrial vertebrates offered an easy and variable food source.

The area surrounding the release site contained several biotopes, with rather differing vegetal cover. The habitat types were evaluated using the method described by Emlen (1956). Several watercourses—the Parma River and several streams—run within the study area. Most of the trees are concentrated along them.

The buzzards were released individually between 0900–1500 H on days without precipitation. Beforehand they were kept on location in an outdoor aviary for 1–2 wk in order for them to habituate to the environment. A radiotag (9 g two stage, BIOTRACK, Wareham, U.K.) was attached some hours before release (Kenward 1987, White and Garrott 1990).

The buzzards were followed virtually continuously from dawn to dusk each day if weather permitted for the first 3 d after release, hereafter referred as "days 1–3." If a bird did not leave the area, it was subsequently monitored intermittently with the same schedule at 1–4 d intervals, until the bird disappeared from the surroundings. That period, including the first 3 d, is hereafter indicated as "all-days." Observations were carried out using 8× binoculars and a 10–40× zoom spotting scope.

The daylight period was equally divided into three sections that were variable during the year based upon the photoperiod. The proportion of time spent in each habitat for each one-third of the daylight period and in every season was arcsin transformed for comparison. The exact time of sunrise and sunset for the geographical coordinates of the area were calculated every 2 wk. The days after release were counted considering the day of release as day one. The days of the year were indicated considering the spring equinox as day zero.

We used the Mann-Whitney U-test to compare means, the Kruskal-Wallis one-way ANOVA (Siegel 1956) to evaluate time durations between seasons or between thirds of the day, the Spearman rank correlation to ascertain possible correlations, and the Chi-square test to compare frequencies. The means are given ± SE, and the probability is always given as two-tailed.

RESULTS

Most buzzards did not disappear quickly from the release site in 426.6 hr of observation (Table 1). The area used by the birds was about 2730 ha in size, almost centered around the release site. One-half of the sampled buzzards left the study area within three days. Three departed within a few hours and one on day three. This occurred in early spring and autumn.

Mortality. Three buzzards died in the study area by electrocution after perching on medium-tension pylons which are widely distributed in the plains of Italy, and unfortunately are a serious problem for other species too. One bird died of a gunshot wound received during the night or at dawn before we started our observation session, and another died in spring for unknown reasons during a late snowfall. Finally, one buzzard was recaptured close to starvation.

Habitat Use. Habitat types within the study area were small. Their distribution was almost regular, and the buzzards moved very easily from one habitat to another. We found great individual variability in habitat use ($H = 31.79$, $N = 450$, $P < 0.001$, measured as minutes spent by each bird in each habitat). Birds that changed habitat frequently had been kept in captivity for the least time ($Z = 2.18$, $N = 279$, $P < 0.05$). During winter, buzzards stayed in one habitat longer than in other seasons, both during days 1–3 ($H = 10.28$, $N = 390$, $P < 0.05$) and in all-days ($H = 17.58$, $N = 485$, $P < 0.001$).

The buzzards remained longer in open habitats than in areas with thick vegetation in every period considered (Kostrzewa 1989). The tendency to explore different habitats immediately after release, i.e., the minutes spent in each habitat before moving to another one, decreased with time ($r_s = 0.10$, $N =$

Table 1. The history of common buzzards released following rehabilitation near Parma, Italy.

BUZZARD IDENTIFICATION CODE	SEX, AGE	DATE OF RELEASE	DAYS REMAINING WITHIN THE STUDY AREA	DURATION OF OBSERVATION (hr)	CAUSE OF OBSERVATION END
VR-340	M, JU	25 Oct 1990	1	1.5	Abandonment[a]
AV-670	F, AD	6 Dec 1990	1	2.8	Abandonment[a]
RN-700	F, JU	27 Mar 1991	1	5.2	Abandonment[a]
V-525	F, AD	11 Apr 1990	3	17.4	Abandonment[a]
O-790	F, JU	15 Jun 1990	4	27.0	Abandonment[a]
VA-425	F, JU	19 Jun 1991	4	25.7	Abandonment[a]
NM-920	M, AD	11 Sep 1991	4	28.2	Abandonment[a]
VN-355	M, JU	13 Apr 1991	7	30.4	Death
RN-670	F, JU	17 Nov 1990	11	37.7	Death
VP-960	M, JU	20 Sep 1991	13	29.0	Death
AN-690	F, AD	16 Mar 1991	14	45.2	Abandonment[a]
B-355	F, JU	30 Apr 1991	18	31.3	Abandonment[a]
A-260	M, JU	9 Jun 1990	29	33.9	Abandonment[a]
GM-440	M, AD	3 Nov 1990	39	46.5	Recapture
RS-1150	F, AD	15 Sep 1991	65	34.7	Abandonment[a]
RA-450	F, AD	23 Jun 1991	103	30.2	Abandonment[a]

[a] Buzzard left the release area.

485, $P < 0.05$). Habitats with trees were used most (74.8% of time), particularly tree rows (55.9%). The time spent in such habitats was inversely correlated with tree distance ($r_s = -0.12$, $N = 310$, $P < 0.05$). The birds preferred those areas in spring, particularly the "irregular" woods ($H = 11.29$, $N = 147$, $P < 0.02$) and poplar plantations ($H = 11.02$, $N = 147$, $P < 0.02$), while in summer they stayed mostly in woods with trees in rows ($H = 12.54$, $N = 146$, $P < 0.01$). Such a preference changed dramatically in autumn and winter, when the birds chose principally open/cultivated areas ($H = 20.55$, $N = 147$, $P < 0.001$). In contrast, they appeared to avoid the vicinity of buildings or other areas where human presence was evident. Only six birds frequented such areas, perching close to human settlements and spending no more than 20% of the observation period there. We found no relationship between time of day and habitat preference. The birds remaining for a long time within the study area were also able to occupy a territory adjacent to or within a territory defended by a wild conspecific, but behaved as subordinate to the latter.

Perching Sites. The buzzards perched most frequently in tree branches, but also often used pylons, poles, or simply stood on the ground. In spring ($N = 148$) they perched most often on poplars (*Populus* spp.; $\chi^2_{(1)} = 111.90$, $P < 0.001$) and willows (*Salix alba*; $\chi^2_{(1)} = 12.99$, $P < 0.001$), while in summer ($N = 221$) they rested in oaks (*Quercus* spp.; $\chi^2_{(1)} = 18.11$, $P < 0.001$) and again in poplars ($\chi^2_{(1)} = 42.75$, $P < 0.001$) and willows $\chi^2_{(1)} = 15.02$, $P < 0.001$). In autumn ($N = 237$) they preferred open habitats and either perched on pylons ($\chi^2_{(1)} = 21.72$, $P < 0.001$), poplars ($\chi^2_{(1)} = 27.16$, $P < 0.001$) or descended to the ground, but in winter ($N = 46$) they returned to a preference for trees, again principally poplars ($\chi^2_{(1)} = 40.45$, $P < 0.001$). The perching duration was unaffected by the type of perching site and averaged 30.70 ± 1.22 min ($N = 652$).

Perch height was negatively correlated with the perching duration in both days 1–3 ($r_s = -0.10$, $N = 486$, $P < 0.05$) and in subsequent time periods ($r_s = -0.09$, $N = 652$, $P < 0.02$). Height was strongly influenced ($H = 37.14$, $N = 652$, $P < 0.001$) by season in either period ranging from 5.26 ± 0.26 m (all-days) in spring to 3.27 ± 0.17 m (all-days) in summer and in winter.

Flight Performance. The buzzards flew some distance away immediately after release, but remained within a range of 400–5000 m. The distance from the release site increased progressively to 1295.0 ± 217.4 m on day three. These values were greatly affected by season ($H = 18.25$, $N = 551$, $P < 0.001$),

Table 2. Some parameters of flapping or gliding flights and soaring for each released buzzard. (It was not possible to ascertain the actual height of all flights.)

BUZZARD IDENTIFICATION CODE	TOTAL NO. OF FLIGHTS	MEAN NO. OF MINUTES BETWEEN TWO FLIGHTS	MEAN NO. OF HOURS BETWEEN TWO SOARING FLIGHTS	MEAN (± SE) HEIGHT (m) OF FLIGHT (*N*)	MEAN (± SE) LENGTH (m) OF FLIGHT (*N*)
AV-670	6	28.3	—	11.5 ± 1.5 (2)	441.7 ± 141.8 (6)
RN-700	8	38.8	5.167	—	491.9 ± 204.6 (8)
VR-340	3	30.0	1.5	—	150.0 ± 57.7 (3)
V-525	11	95.0	8.733	75.0 ± 0.0 (2)	336.4 ± 134.7 (11)
O-790	25	64.8	—	—	173.0 ± 17.8 (25)
GM-440	51	49.1	46.633	—	187.4 ± 18.2 (51)
NM-920	48	35.2	28.167	9.1 ± 1.9 (26)	176.6 ± 17.6 (48)
VA-425	45	34.2	—	8.2 ± 0.7 (26)	161.1 ± 14.9 (45)
VN-355	76	27.2	15.217	14.8 ± 2.8 (29)	185.0 ± 20.1 (76)
RN-670	90	24.8	—	—	186.7 ± 18.3 (90)
AN-690	54	50.2	—	18.5 ± 11.5 (52)	160.6 ± 15.0 (54)
VP-960	47	37.0	5.793	18.3 ± 7.1 (19)	281.4 ± 41.9 (47)
B-355	42	25.4	7.829	22.1 ± 5.1 (16)	245.8 ± 37.7 (42)
A-260	62	33.4	11.305	—	219.4 ± 22.1 (62)
RS-1150	73	28.5	34.683	7.5 ± 1.4 (51)	186.3 ± 20.7 (73)
RA-450	51	35.5	30.183	7.0 ± 0.9 (43)	132.8 ± 12.1 (51)

with longer distances in autumn (1043 ± 206 m) and shorter in winter (536 ± 93 m). The time of day did not have any influence.

Most flights involved flapping and gliding with soaring being recorded only at the beginning of spring and autumn. The frequency of flights was highly variable between individuals ($H = 25.11$, $N = 126$, $P < 0.05$), with intervals between two flights ranging from 24.8–95.0 min/bird (Table 2). High frequency of flights was associated with short rehabilitation period ($Z = 2.65$, $N = 11$, $P < 0.01$). The longest flights were in autumn and spring (221.7 ± 14.5 m [$N = 218$] and 223.3 ± 15.0 m [$N = 234$], respectively, in all-days), showing a significant difference among seasons ($H = 12.46$, $N = 692$, $P < 0.01$ in all-days). Flight length increased with distance from release site ($r_s = 0.13$, $N = 692$, $P < 0.001$). Flight height and length were positively correlated ($r_s = 0.31$, $N = 219$, $P < 0.001$).

Predatory Behavior. We recorded 92 predation attempts, 55 of which occurred during days 1–3. Twelve birds out of the 16 studied attempted to catch prey at least once (7.67 ± 2.13 attempts/bird), with much individual variation (one attempt every 1.3 hr to one every 33.9 hr). The four buzzards that died or were recaptured had higher mean frequencies than the surviving birds (one attempt every 2.7 ± 0.5 hr vs. one attempt every 17.0 ± 4.1 hr, $Z = 2.12$, $N = 12$, $P < 0.05$). More attempts were recorded during autumn ($N = 43$, one attempt every 2.9 hr) and spring ($N = 32$, one attempt every 4.1 hr) than in winter ($N = 3$, occurring every 12.5 hr). The interval between two prey capture attempts was very variable ($H = 20.09$, $N = 48$, $P < 0.05$). Moreover, the frequency of the attempts increased in relation to days after release ($r_s = 0.35$, $N = 48$, $P < 0.05$).

Buzzards generally hunted from perches (87.0% of total attempts). Only 12 hunts were performed by walking or standing on the ground and only three birds displayed these patterns. Range of prey taken was variable, being mainly comprised of mammals, reptiles, and insects. Although the common buzzard is well able to capture birds (Tubbs 1974), these were not included in our hunting observations in contrast to observations by Lovari (1974). When hunting from perches, buzzards started from a mean height of 4.36 ± 0.26 m. Neither the substrate nor the outcome were related to the height. The quarry was caught at a mean distance of 13.06 ± 1.11 m from the perch (range 2–60 m).

The predation angle, i.e., the angle between the vertical from the perch to the ground and the path from the perch to the prey, supposing a linear glide, covered a wide range (0–85°). This angle was af-

fected by habitat substrate during days 1–3 (H = 9.92, N = 50, $P < 0.05$). Uncultivated and grass fields accounted for the highest percentage of successful attempts (N = 10). Banks of watercourses accounted for 42.9% of uncertain successes (N = 14), but the percentage of success related to the grass fields was only 7.1%. Uncultivated or plowed fields produced intermediate results. Unsuccessful attempts (N = 26) were mainly recorded in grass fields (38.4%), watercourse banks (34.6%), and plowed fields (19.2%).

The season strongly influenced both the type of perch used for predation attempts ($\chi^2_{(3)} = 42.65$, $P < 0.001$) and the type of habitat substrate where the attempt was performed ($\chi^2_{(3)} = 8.61$, $P < 0.05$). In fact, buzzards preferred to hunt from rows of trees in spring ($P < 0.001$) and from pylons in autumn ($P < 0.001$). Most predation attempts occurred on the grass fields during the cold season.

Interactions with Conspecifics and Other Bird Species. A total of 29 interactions with resident wild buzzards was recorded involving five birds out of the 16 released. Most interactions occurred in summer and autumn (24.1% and 62.1%, respectively; cf. Kostrzewa 1991), and we did not record any interaction in winter. Such interactions occurred soon after release; in fact, approximately one-half occurred in days 1–3. The interval between two interactions decreased markedly with days ($r_s = -0.56$, $N = 20$, $P < 0.05$), reaching the maximum value between day 10–30 post-release. The interactions occurred mostly when the released buzzard was perched and were rather variable in duration (range: 5 sec–35 min.), and negatively correlated with perch height ($r_s = -0.66$, $N = 15$, $P < 0.05$). An interaction between two soaring birds was recorded only once. Vocalizations were very frequent during interactions, as observed also by Tubbs (1974).

Wild buzzards attacked first in 55.1% of interactions and the released bird attacked first only in 13.7% of times. Fighting, although of short duration, occurred in 6.8% of observations. In these cases neither buzzard showed a tendency to leave. Attacks by the released buzzard never occurred on day one. Released buzzards that interacted with wild ones scored higher in predation frequency than those not interacting ($Z = 2.11$, $N = 12$, $P < 0.05$). The three birds that interacted most frequently eventually died or were recaptured.

The buzzards in this study interacted with several corvid species much more frequently than with conspecifics: 317 interactions involving the hooded crow (*Corvus corone*), 63 involved the magpie (*Pica pica*), and 50 the jay (*Garrulus glandarius*). The mean frequency of interaction with the hooded crow was highest in spring and lowest in autumn. The interactions with the magpie were most frequent in autumn and very rare in winter, and those with the jay were rare in winter but similar in the other seasons. Interactions without regard to the bird species most often occurred among rows of trees, ranging from 92.0% for jays to 54.6% for hooded crow. The latter species also frequently mobbed buzzards in open areas (27.4%) and in other types of woods (17.2%). The number of mobbing individuals was highly variable with the maximum by the hooded crow (up to 12 birds and up to eight in the magpie and three in the jay). The corvids involved in mobbing often performed true attacks on the buzzard. The latter, however, generally paid no apparent attention to them. The mobbing rate, without regard to the corvid species, varied between the seasons ($\chi^2_{(6)} = 19.30$, $P < 0.01$). The attacks were continuous (more than one attack/10 sec) in spring, at intervals (less than one attack/10 sec) in autumn, and rare (less than one attack/60 sec) in winter. The season greatly affected both the number of attacking birds and the total duration of the interaction (Table 3). The maximum number of mobbing individuals was much higher in spring and summer in all corvid species (H = 12.85, N = 317, $P < 0.001$ in the hooded crow; H = 9.93, N = 63, $P < 0.05$ in the magpie; H = 16.59, N = 50, $P < 0.001$ in the jay). Corvids mobbed longer in spring and summer (jay and magpie). The frequency of interaction decreased with number of days post-release for hooded crow $r = 0.22$, $N = 92$, $P < 0.05$) but not for the magpie and jay. Similarly, the frequency of vocalizations by the mobbing hooded crows was affected by the season ($\chi^2_{(6)} = 87.48$, $P < 0.001$). Vocalizations were almost continuous (more than one vocalization/5 sec) in spring, less frequent (less than one vocalization/5 sec) in winter, and virtually absent in autumn.

Several other bird species interacted with released buzzards, but these were too infrequent to allow statistical evaluation. Seventeen interactions occurred with common kestrels (*Falco tinnunculus*), mostly during spring near the kestrels' nests. A few interactions occurred with the marsh harrier (*Circus aeruginosus*) and hen harrier (*Circus cyaneus*) during autumn and winter in open habitats. Interactions with sparrowhawks (*Accipiter nisus*) occurred at the

Table 3. The mean (±SE) duration (minutes) of interactions and the mean (±SE) number of attacking birds in three corvid species in each season.

	HOODED CROW		MAGPIE		JAY	
SEASON	DURATION	NO. BIRDS	DURATION	NO. BIRDS	DURATION	NO. BIRDS
Spring	5.62 ± 0.59	1.50 ± 0.16	4.38 ± 1.13	0.83 ± 0.32	4.47 ± 0.86	1.08 ± 0.23
Summer	9.89 ± 1.21	1.56 ± 0.16	4.37 ± 0.98	0.29 ± 0.24	3.82 ± 0.95	0.69 ± 0.24
Autumn	9.42 ± 1.74	0.91 ± 0.13	1.88 ± 0.31	0.06 ± 0.04	1.05 ± 0.21	0.05 ± 0.05
Winter	14.54 ± 3.22	0.84 ± 0.18	1.85 ± 0.35	0.00 ± 0.00	2.70 ± 0.30	0.00 ± 0.00

end of spring. Finally, several non-corvid Passeriformes and two species of Columbidae interacted occasionally.

DISCUSSION

Many of the buzzards were able to survive for several weeks around the release site. Although varying in timing and direction, the abandonment of the release site was similar to what has been recorded for rehabilitated congeneric American species (Hamilton et al. 1988). However, we recorded a greater distance than reported for buzzards released in wooded habitat (Llewellyn and Brain 1983) suggesting that areas lacking large woods are likely not attractive for long-term occupation, possibly because of the lack of hiding places. The survival of buzzards for prolonged time in this study shows that release in areas heavily populated by humans is not very detrimental to the birds as was claimed by Hamilton et al. (1988).

On the other hand, lack of muscle tone just after release likely reduces the readiness to disperse from the release site (Servheen and English 1979). Low muscle tone is certainly caused by prolonged captivity that in turn is correlated with the frequency of flights and quick dispersal. Nevertheless, it is unlikely that it induces great vulnerability to the bird as claimed by Duke et al. (1981). Although repeated flights in training aviaries at the RRC were very important, they seemed to be inadequate for long distance flights soon after release. Nonetheless, good muscle tone and endurance appeared to be achieved in a very few days.

Similar to American species (Duke et al. 1981), the season that release occurred in clearly affected the time of dispersal and the type of flight. In fact, although the Italian population is basically non-migratory, the type of flights performed in spring and autumn (higher, longer, and frequent soaring) are associated with a migratory behavior. Moreover, quick departure from the release site was recorded only during the migration period.

The frequency of hunting attempts by our released birds was high and possibly underestimated. Our data do not support the hypothesis by Hamilton et al. (1988) that in red-tailed hawks (*Buteo jamaicensis*) and broad-winged hawks (*Buteo lineatus*) unfamiliarity with the new area or captive feeding negatively affect hunting behavior. Even other parameters related to prey catching ability, attack glide (Wakeley 1978), and the prey attack angle (Janes 1985) were similar to those of congeneric wild birds.

Predatory proficiency of our birds likely improved with repetition. Prolonged captivity did not seem to be detrimental to hunting ability from perches, as previously suggested in laboratory conditions (Csermely et al. 1991). Such an ability is shown by the wide range of taxa taken as prey by our rehabilitated birds, a range very similar to the diet of wild Mediterranean populations (Lovari 1974, Manzi and Pellegrini 1989, Mañosa and Cordero 1992). The increased success of prey capture with days post-release was possibly connected to an increased knowledge of the environment. The increase in hunting attempts in migratory periods may have been due to increases in metabolism connected with migration. Retaliation to a wild buzzard attack was rare in the early post-release days but the frequency of interactions increased with time after release. Interactions, although frequent during reproductive and migration periods (Brown 1989), did not cause buzzards to leave the area which was opposite of the case for red-tailed hawks (Hamilton et al. 1988). Mobbing by corvids seemed to cause only the buzzard's abandonment of perches. This was true in spring and summer, when the corvids have greater parental motivation toward antipredatory behavior

(Röell 1982). The hooded crow, due to its large size and great sociality, is the species with the greatest ability to chase buzzards. However, antipredatory behavior by the corvids did not seem to have a very detrimental effect on buzzard releases.

In conclusion, released buzzards showed a ready ability to cope with the environment and to acclimate to the wild. Prey was captured quite easily even after prolonged captivity, although a certain level of training was evident. Moderate human presence around the release site did not appear detrimental. A greater source of interference likely came from mobbing corvids that sometimes forced buzzards to move from perches. From an applied point of view we can say that the rehabilitation technique was basically correct, because none of the buzzards showed evident behavioral modifications related to the captivity period.

ACKNOWLEDGMENTS

We are greatly indebted to Daniele Ghillani, Maurizio Ravasini, and Marco Lambertini of the Italian Society for the Protection of Birds, as well as the whole staff of the Raptor Rehabilitation Centre of Parma, for the help provided and the permission to use the RRC facilities and the birds housed there. We thank also the Parma Provincial Administration for the permission to release the buzzards on its territory. The comments and criticisms by Achim Kostrzewa, Santi Mañosa, Gary Duke and an anonymous referee offered many valuable insights to improve an earlier draft of the manuscript. The basic stimulus for developing this study came from discussions with Nicolantonio Agostini. The research was supported by the Italian Ministero Università e Ricerca Scientifica e Tecnologica and the Consiglio Nazionale delle Ricerche.

LITERATURE CITED

BROWN, L. 1989. British birds of prey. Bloomsbury Books, London, U.K.

CSERMELY, D., N. AGOSTINI AND D. MAINARDI. 1991. Predatory behaviour in captive wild Buzzard. *Birds Prey Bull.* 4:133–142.

DUKE, G.E., P.T. REDIG AND W. JONES. 1981. Recoveries and resightings of released rehabilitated raptors. *Raptor Res.* 15:97–107.

EMLEN, J.T. 1956. A method for describing and comparing avian habitats. *Ibis* 98:565–576.

HAMILTON, L.L., P.J. ZWANK AND G.H. OLSEN. 1988. Movements and survival of released, rehabilitated hawks. *Raptor Res.* 22:22–26.

INGRAM, K.A. 1983. Release and survival of a one-eyed golden eagle. *Ann. Proc. Am. Assoc. Zoo Vet.* 1983:160.

JANES, S.W. 1985. Habitat selection in raptorial birds. Pages 159–188 *in* M.L. Cody [ED.], Habitat selection in birds. Academic Press, London, U.K.

KENWARD, R. 1987. Wildlife radio tagging. Academic Press, London, U.K.

KOSTRZEWA, A. 1989. Nest habitat separation in three European raptors: *Accipiter gentilis, Buteo buteo* and *Pernis apivorus*—A multivariate analysis. Pages 553–559 *in* B.-U. Meyburg and R.D. Chancellor [EDS.], Raptors in the modern world. World Working Group Birds Prey, Berlin, Germany.

———. 1991. Interspecific interference competition in three European raptor species. *Ethol. Ecol. Evol.* 3:127–143.

KOSTRZEWA, R. AND A. KOSTRZEWA. 1991. Winter weather, spring and summer density, and subsequent breeding success of Eurasian kestrels, common buzzards, and northern goshawks. *Auk* 108:342–347.

LLWELLYN, P.J. 1991. Assessing adult raptors prior to release. Pages 33–47 *in* Raptor rehabilitation workshop. London Zoo, The Hawk Trust, The Hawk Board, London, U.K.

——— AND P.F. BRAIN. 1983. Guidelines for the rehabilitation of injured raptors. *Int. Zoo Yearb.* 23:121–125.

LOVARI, S. 1974. The feeding habits of four raptors in central Italy. *Raptor Res.* 8:45–57.

MANZI, A. AND M. PELLEGRINI. 1989. Dati sulla biologia riproduttiva della poiana (*Buteo buteo*) in un'area della fascia collinare abruzzese. *Avocetta* 13:109–114.

MAÑOSA, S. AND P.J. CORDERO. 1992. Seasonal and sexual variation in the diet of the common buzzard in northeastern Spain. *J. Raptor Res.* 26:235–238.

MEYERS, J.M. AND D.L. MILLER. 1992. Post-release activity of captive- and wild-reared bald eagles. *J. Wildl Manage.* 56:744–749.

NELSON, R.W. 1977. On the diagnosis and "cure" of imprinting in falcons which fail to breed in captivity Pages 39–49 *in* J.E. Cooper and R.E. Kenward [EDS.], Papers on the veterinary medicine and domestic breeding of diurnal birds of prey. British Falconers' Club, Oxford, U.K.

PENDLETON, B.A.G., B.A. MILLSAP AND K.W. CLINE 1987. Raptor management techniques manual. Nat. Wildl. Fed., Sci. Tech. Ser. No. 10, Washington, DC U.S.A.

RÖELL, A. 1982. A comparison of nest defence by jackdaws, rooks, magpies and crows. *Behav. Ecol. Sociobiol* 11:1–6.

SERVHEEN, C. AND W. ENGLISH. 1979. Movements of rehabilitated bald eagles and proposed seasonal movements patterns of bald eagles in the Pacific northwest. *Raptor Res.* 13:79–88.

SHERROD, S.K., W.R. HEINRICH, W.A. BURNHAM, J.H. BARCLAY AND T.J. CADE. 1982. Hacking: a method for releasing peregrine falcons and other birds of prey. The Peregrine Fund, Boise, ID U.S.A.

SIEGEL, S. 1956. Nonparametric statistics for the be-

havioral sciences. McGraw-Hill Book Co., New York, NY U.S.A.

TUBBS, C.R. 1974. The buzzard. David & Charles, London, U.K.

WAKELEY, J.S. 1978. Hunting methods and factor affecting their use by ferruginous hawks. *Condor* 80:327–333.

WEAVER, J.D AND T.J. CADE (EDS.). 1991. Falcon propagation. The Peregrine Fund, Boise, ID U.S.A.

WHITE, G.C. AND R.A. GARROTT. 1990. Analysis of wildlife radio-tracking data. Academic Press, San Diego, CA U.S.A.

Received 8 July 1993; accepted 8 February 1994